

REMARKS

Claims 1 – 18 are in the application.

Claims 1, 9-10 and 15 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Collier, Jr. (Patent No. 6,405,720 B1), in view of Hansel (Patent No. 5,524,432). The Examiner states that Collier discloses a hydrogen fueled reciprocating spark ignition engine including a fuel system for providing gaseous hydrogen to the cylinders of the engine and a catalytic converter coupled to the engine for treating engine's exhaust. The Examiner continues that Collier also shows an EGR system for providing recirculated exhaust gas and a controller for operating the fuel system and the EGR system during periodic purging of the catalytic converter such that the engine is operated at a richer-than stoichiometric air/fuel ratio, and with the mass of EGR approximating 40% – 80% of the mass of air and fuel. The Examiner states that Collier fails to disclose that the converter is a NOx catalyst. The Examiner turns to Hansel for a NOx catalyst, and concludes that it would have been obvious to place Hansel's NOx catalyst into Collier's engine system. And as to Applicants' claims 9 and 10, the Examiner states that Hansel shows a NOx sensor and an SCR converter mounted downstream from a lean NOx catalyst. Applicants respectfully traverse this rejection and request that Claims 1, 9-10, and 15 be reconsidered in view of these remarks and passed to issue over the Examiner's rejection. Such action is earnestly solicited.

19 Collier discloses an engine which is dual fueled and which is intended to be operated predominantly upon natural gas, with either hydrogen and or carbon monoxide being added (Collier Col. 6, lines 17 – 26). In contrast, Applicants' engine is intended to run solely and exclusively on hydrogen and is accordingly called a "Hydrogen Fueled Spark Ignition Engine". Collier's catalyst 14 is described as a oxidizing catalyst. Collier Col. 5, lines 1 – 5. In contrast, Applicants aftertreatment device is set forth in the claims as being a NOx trap. NOx traps are devices which collect NOx while operating under lean air/fuel ratio, but which must be periodically regenerated or purged of NOx by temporarily operating at a rich air/fuel ratio.

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1 The Examiner states that Collier discloses a controller for operating the fuel system and EGR system but he offers no authority for this proposition. Collier does not disclose a controller. The Examiner states that Collier purges a NOx trap by operating the engine at a richer-than stoichiometric air/fuel ratio. However, at Col. 6, line 17 – 27, Collier discusses running up to a range of .99 equivalent ratio. Collier never runs his engine fuel rich. Clearly, Collier never purges his catalyst in any respect. In contrast, as set forth in Applicants' specification and claims, Applicants periodically run fuel rich at 1.1 equivalent ratio so as to purge Applicants' lean NOx trap of accumulated NOx. In sum, Collier does not disclose either a NOx trap, or an engine controller, or periodic operation at a rich air/fuel ratio, coupled with heavy EGR during purging of the NOx trap.

11 Hansel discloses a diesel engine operating on methane and having a reducing catalyst mounted upstream from an oxidizing catalyst. Hansel therefore teaches nothing relevant to operation of a spark ignition engine on hydrogen, with the engine operating with a lean NOx trap, with periodic operation fuel rich and at high EGR rates so as to avoid pre-ignition with hydrogen during the regeneration process. In short, neither Collier nor Hansel, whether taken singly, or in combination with each other, either teaches or suggests Applicants' claimed invention as set forth in Claims 1, 9-10, and 15. Neither Collier nor Hansel, whether taken singly, or in combination with each other, teaches anything about operating an engine with a lean NOx trap requiring periodic regeneration, and neither reference can form even a colorable basis for the rejection of claims 1, 9-10 and 15, and these Claims should be passed to issue over the Examiner's rejection. Such action is earnestly solicited.

12 Claims 5 - 6, 12 -13 and 16 - 18 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Collier in view of design choice. The Examiner argues that Collier discloses everything found in Claims 5 – 6, 12 – 13 and 16 – 18 except for the choice of compression ratio and equivalence ratio. Applicants respectfully traverse this rejection and request that each of Claims 5 – 6, 12 – 13 and 16 – 18 be reconsidered in view of these remarks and passed to issue over the Examiner's rejection.

As noted above, Collier does not disclose a system having an EGR trap, nor does he disclose operating the system fuel rich during purging of the EGR trap, and he certainly does not disclose operating an engine with an EGR trap fuel rich with the mass of EGR approximately 40% to 80% of the mass of air and fuel. As a result, Collier cannot be used as a basis of rejection of Claim 5, which sets forth compression ratio of the engine as being greater than 10 to 1, or Claim 6, which sets forth that the compression ratio of the engine is within the range of 14 to 15 to 1. Furthermore, Claims 12 and 13 indicate equivalence ratio operation when Applicant's lean NOx trap is being purged, or when the engine is being operated at or near maximum load. Collier is devoid of any teaching or suggestion regarding the handling of NOx traps in such a situation. It should be noted that Claims 5-6 and 12-13 all depend from Claim 1, which is itself patentable over Collier, whether taken singly, or in combination with Hansel.

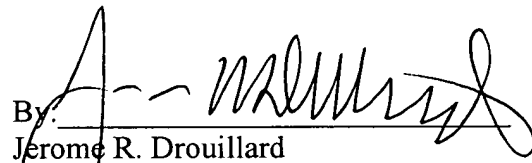
With respect to Claims 16 – 18, as noted above, Collier teaches nothing regarding operation of an engine having a lean NOx trap such that the engine is operated at an equivalence ratio of 0.15 to 0.65 except when purging the lean NOx trap, with the engine being operated at an equivalence ratio of about 1.1 when purging the NOx trap. Collier discloses an oxidation catalyst which is not a NOx trap, nor does it function in the manner of a NOx trap. Rather, an oxidation catalyst merely completes combustion of carbon monoxide to carbon dioxide before the exhaust gas is discharged. Collier notes this himself, at Col. 6, lines 40 – 56. As a result, each of Claims 5 – 6, 12 – 13 and 16 – 18 should be passed to issue over the Examiner's rejection. Such action is earnestly solicited.

Claims 8, 11 and 14 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Collier in view of Oshima et al. (Patent No. 5,272,871). The Examiner cites Oshima for the teaching that is conventional to position a 3-way catalyst upstream of a lean NOx trap. The Examiner is in error, however, because Oshima does not teach anything about operating an engine with a lean NOx trap on hydrogen, with the claimed operation at a very lean air/fuel ratio followed by periodic operation at fuel-rich air/fuel ratio with high EGR rates. Oshima uses a NOx catalyst which is continuously supplied with hydrogen gas injected immediately upstream of the NOx catalyst. Applicants supply excess fuel only when it is necessary to

regenerate the lean NOx trap. Thus, Oshima wastes fuel. Another difference between the claimed invention and the Collier reference resides in the fact Collier apparently operates at high EGR rates during the entire engine operation. This is noted as being undesirable because it reduces the power output of the engine remarkably. In sum, Claims 8, 11 and 14 are patentable over Collier in view of Oshima and should be passed to issue. Such action is earnestly solicited.

Claims 2 – 4 and 7 are indicated as being objected to as being dependent upon a rejected base claim. The Applicants respectfully request that Claims 2 – 4 and 7 be passed to issue along with the other claims remaining in this case. Such action is earnestly solicited.

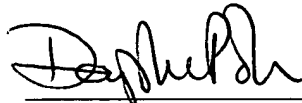
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CERTIFICATE OF MAILING

I hereby certify that the enclosed Amendment is being deposited with the United States Postal Service as first class mail, postage prepaid, in an envelope addressed to Mail Stop Non-Fee Amendment, Commissioner of Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on this 24 day of November 2003.


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